



An Energy Efficiency Workshop & Exposition

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Palm Springs, California

*Please be courteous to our speakers*



***Turn off all cell phones  
and  
Set pagers to vibrate***



## *Waste To Watts Introduction*

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## *Typical 30 kW Microturbine*

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## *Turbine Exhaust Waste Heat*



**Configurations  
available for 1- 4  
Microturbines**

**Extruded aluminum  
finned tubes with  
copper liners and  
steel headers**

**Exhaust diverter  
valve to dispose  
excess heat**



## *Waste Water Treatment Plant Application*

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- (a) 2 – 30 Kw micro turbines
- (b) Compressor and Heat Exchanger
- (c) Fueled by anaerobic digester gas



## *Turbine Exhaust as Intake Air to Boiler*

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- Relatively constant thermal load
- Long run hours
- 1 MM Btu/hr (400 hp) boiler or greater
- Mission critical application
  - Process application such as food processing



## *Turbine Performance and Output*

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Net Output (%)	100	90	80	70
Efficiency (%)	27.7	25	22.2	17.4
Fuel Costs (\$/mmBtu)	<u>Cents per kWhr Conversion</u>			
4.00	5.47	6.07	6.83	7.81
6.00	8.20	9.11	10.25	11.71
8.00	10.93	12.15	13.12	15.62



## *Turbine Performance and Inlet Air Temperature*

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Air Inlet Temp (F)

Efficiency (%)

59

28.0

68

26.5

77

25.0

86

23.5

Sea Level





## *Combined Heat and Power Costs*

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	Sensible	S&L adder
Turbines (*)	105,503	
Heat Ex	9,333	-9,333
Compressor	5,610	
Site Prep	2,500	
Electrical Connections	3,000	
Gas Connections	2,000	
Permits	500	
Ducting & Insulatio	754	2,133
Shipping and Handling	----	----
Total	\$ 1538/kW(**)	\$ 1452/kW(**)

(\*) Master Turbine - 25,960; 3 Slave Turbines - 77,220; Remote Monitoring - 1,540; Natural Gas Kit - 462; Emergency Stop - 198; and MultiPac Cable - 123

(\*\*) 30 kW units derated to 28 kW to supply compressor



## *“Free” Fuel Assumptions*

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There are applications where microturbine fuel is available at little or no costs. Some examples include Flare Gas, Coal Bed Methane, Municipal, Industrial, and Agricultural Sewage Treatment Plants, and Landfills. Heat recovery may or may not be practical in these applications.



## *CHP Bottom Line*

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Application	Sensible	Sens&Lat
Capital Recovery	2.02	1.91
O&M	1.50	1.50
Fuel	8.78	8.78
Heat Rec. Adjustment	<u>(1.97)</u>	<u>(4.28)</u>
Total	10.33 c/kWhr	7.91 c/kWhr

Assumption: Sea Level, 75 F inlet temp, 100% output, 60 cents per therm, 95% availability, 8% interest and 10 year capital recovery



## *Free Fuel Bottom Line*

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	Sensible	Sens&Lat	w/o Heat Rec
Capital Recovery	2.02	1.91	1.86
O&M	1.50	1.50	1.50
Fuel	--	--	--
Heat Rec. Adj.	<u>(1.97)</u>	<u>(4.28)</u>	<u>--</u>
Total	1.55 c/kWh	-0.87 c/kWh	3.36 c/kWh



# Q and A

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